USER-MANUAL

TLC15

TLC30

(MKII)

Tamson Instruments B.V.

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CONTENTS

1 SAFETY AND WARNINGS 4
2 Warranty 4
3 EC declaration of conformity 5
4 Precautions and hazards 6
5 INSTALLATION 6
5.1 UNPACKING 6
5.2 PLACEMENT AND VENTILATION 7
5.3 INITIAL USE 7
5.4 BATH LIQUIDS 8
6 CONNECTING 9
6.1 CLEANING 10
7 Introduction to the TLC series 11
7.1 GENERAL 11
7.2 PUMP 11
7.3 TEMPERATURE CONTROL 12
8 Operation 12
8.1 SWITCHING ON 12
8.2 CAUTION WITH POWERING ON/OFF 12
8.3 SAFETY SYSTEMS 13
8.4 ADJUSTING THE MECHANICAL OVER-TEMPERATURE PROTECTION THERMOSTAT 13
8.5 CONTROL PANEL 13
8.6 BACKSIDE APPARATUS 14
8.7 FRONT PANEL KEYS 14
9 OPERATING THE SYSTEM 14
9.1 DISPLAY READOUT 16
9.2 QUICK START, ADJUST SET POINT 17
9.3 TUNING 17
9.4 MANUAL TUNING 18
10 Menu items 18
10.1.1 Menu item "Setpoint" 19
10.1.2 Menu item "Offset" 19
10.1.3 Menu item "Max Power" 19
10.1.4 Menu item "Boost heater" 19
10.1.5 Menu item "Time const" 19
10.1.6 Menu item "Stirrer" 19
10.1.7 Menu item "Low alarm" 19
10.1.8 Menu item "High alarm" 20
10.1.9 Menu item "PID parameter" 20
10.1.10 Menu item "Backlight" 20
10.1.11 Menu item "Temp units" 20
10.1.12 Menu item "Baudrate" 20
10.1.13 Menu item "Restart" 20
10.2 PID CONFIGURATION 21
10.3 MANUAL TUNING 21
10.4 STANDARD PID SETTINGS 22
10.5 DRAINING BATH FLUID 22
10.5.1 Using the drain tap 23
10.6 MAINTENANCE 23
10.7 MAINTENANCE 24
11 TROUBLE SHOOTING 24
11.1 GENERAL 24
11.2 FAULTY TEMPERATURE READINGS 25
12 SPECIFICATIONS 26
12.1 TECHNICAL SPECIFICATIONS OVERVIEW 26
12.2 TLC15 PERFORMANCE 27
12.2.1 Stability TLC15 - TLC30 27

12.2.2 Cool down TLC15 27
12.2.3 Cooldown TLC15 27
12.2.4 Cooldown TLC30 27
12.3 SPARE PARTS LIST TLC15/TLC30 28
13 PRINCIPAL OF OPERATION 28
14 DISCLAIMER 29

1 SAFETY AND WARNINGS

Make sure before installing or operating the equipment to read and understand all instructions and safety precautions listed in this manual. If there are any questions concerning the operation of the equipment or about the information given in this manual please contact your local dealer or our sales department first.

Performance of installation, operation, or maintenance other than those described in this manual may result in a hazardous situation and may void the manufacturer's warranty.

Never operate equipment that is not correctly installed. Unqualified personnel must not operate the equipment. Avoid damage to the equipment, or its accessories, caused by incorrect operation.

Important:
When performing service, maintenance or moving the apparatus, always disconnect the line cord of the apparatus,
Proper skilled and trained personnel are only allowed to operate this equipment,
Take notice of warning labels and never remove them,
Refer service and repairs to qualified technician,
If a problem persists, call your supplier or Tamson Instruments B.V.

2 Warranty

Tamson Instruments B.V. warrants that all their manufactured equipment is free from defects in material and workmanship, preventing the machine from normal operation. Tamson Instruments B.V. does not warranty that the equipment is fit for any other use than stated in this manual. The manufacturer can only be held responsible for the security, reliability and performance of the equipment, when operated in accordance with the operating instructions, extensions, adjustments, changes and/or if repair is performed by Tamson Instruments B.V. or authorized persons only. This warranty is limited to one year from the date of invoicing. All equipment and materials are subject to standard production tolerances and variations.

3 EC DECLARATION OF CONFORMITY

Manufacturer: Tamson Instruments bv
van 't Hoffstraat 12
2665 JL Bleiswijk
The Netherlands

Product: Thermostatic bath and circulator

Model: TLC15/TLC30 (MKII)

We declare that the product mentioned above conforms to the essential's exigency of the directive 2006/42/EC relative to machinery, directives 2004/108/EC relatives to electromagnetic compatibility and directive 2006/95/EC relative to low voltage.

The products are in conformity with the following specifications:

EMC (2004/108/EG)

Conducted emission	- EN55016-2-1 + EN61326+A1
Radiated emission	- EN55016-2-3 + EN61326+A1+A2+A3
Harmonics	- EN61000-3-2
ESD	- EN61326 +A1+A2+A3 and EN61000-4-2 +A1+A2
Radiated immunity	- EN61000-4-3 +A1
Electrical Fast Transients	- EN61000-4-4+A1+A2
Surges	- EN61000-4-5+A1
Conducted immunity	- EN 61000-4-6+A1
Voltage dips and Voltage variations	- EN61000-4-11 +A1

Low voltage (2006/95/EC):

Safety requirements for electrical equipment for measurement, control, and laboratory use Part 1, General requirements,
EN 61010-1-2010
Safety requirements for electrical equipment for measurement, control, and laboratory use Part 2, Particular requirements for laboratory equipment for the heating of material,
EN 61010-2-010-2003

Machinery directive (2006/42/EC)

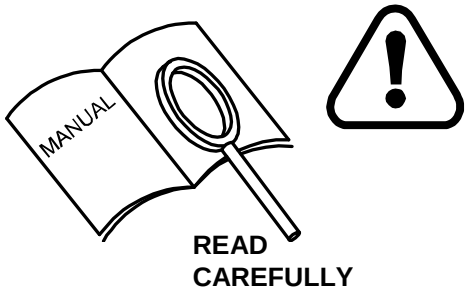
2006-42-ec-2nd-2010

2013, Tamson Instruments bv, The Netherlands,

Name : R.C. van Hall
Function : Director

4 PRECAUTIONS AND HAZARDS

Before attempting to operate the bath read all parts of this manual carefully to insure smooth operation and avoid damage to the equipment or its accessories.



READ CAREFULLY

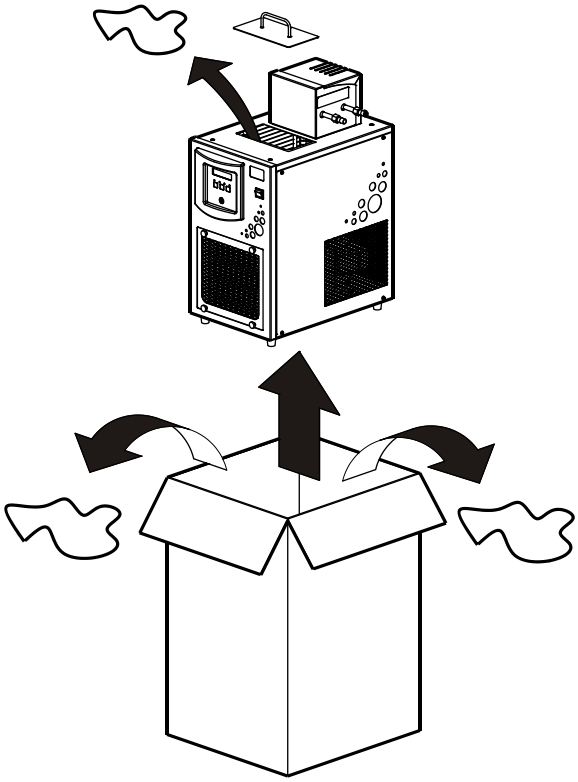
If a malfunction occurs, consult section "TROUBLE SHOOTING", page 24
If a problem persists, call your supplier or Tamson Instruments B.V. Never operate the equipment if not correctly installed. The equipment must be operated only by qualified personnel. Avoid damage to the equipment or its accessories through incorrect operation.

5 INSTALLATION

Tamson Instruments B.V. is not responsible for any consequential damage or harm caused by using this bath. Repairs on the electrical system of the bath may only be carried out by well trained and authorized persons.

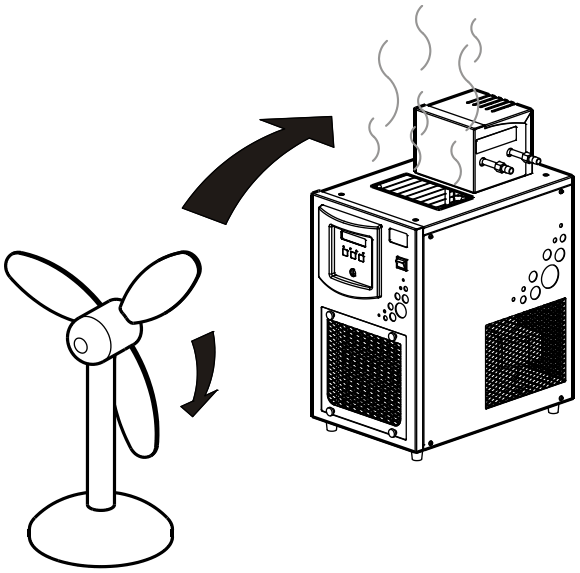
5.1 Unpacking

To avoid damage during transport all Tamson baths are carefully packed for shipment. Check the packaging for external damage and make a note on the shipping documents if any damage is found. Always retain the cartons and packing material until the bath has been tested and found in good condition. Transport companies generally will not honor a claim for damages if the respective box is not available for examination. The shipment contains at least the bath/circulator. The consignment may contain other parts, individually packed in small boxes. Please see packing list for details concerning total contents of consignment.



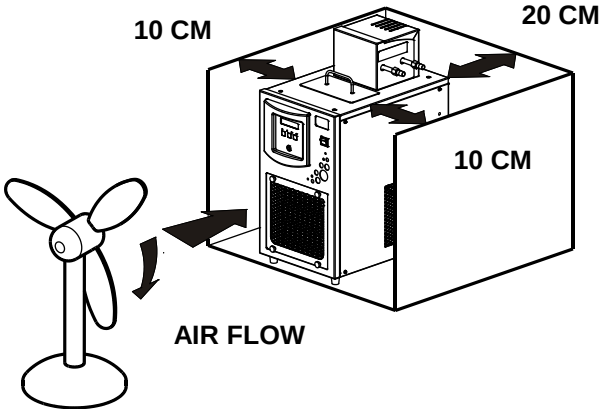
Before filling the bath remove any remaining packing material from its interior. The interior of the bath can be accessed by taking off the lid on the top of the bath.

5.2 Placement and ventilation



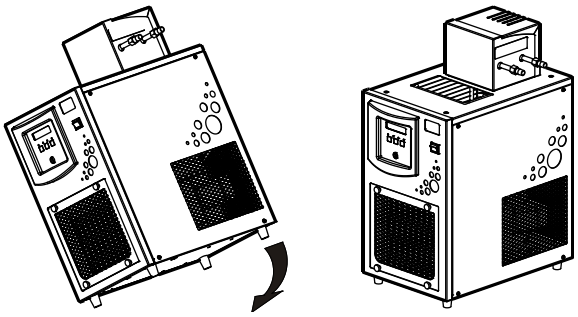
The bath has to be placed in a well ventilated area.

Do not place the bath in a dusty environment. Dust will block the condenser unit inside the apparatus which will lead to severe mechanical damage.



Air circulation has to be enabled by 10 cm of free space at both sides and 15 to 20 cm at the rear of the bath.

5.3 Initial use



Due to transportation allow the bath a 24 hour period for stabilization. This applies also when the apparatus has been tilted or fallen.

Do not switch on power, because lubrication-oil inside the compressor system has to run into the capillary.
It will take several hours before the oil has flown back into the compressor unit. When the apparatus is immediately turned on after it has been tilted, severe damage may occur to the compressor unit due to insufficient lubrication.

5.4 Bath liquids

Methanol can be used as bath liquid, enabling circulation at very low temperatures. Methanol however is extremely flammable and can cause fire hazard. Take all necessary precautions to reduce fire hazard.

Methanol also is toxic and can cause health risks. Use appropriate ventilation and other precautions to prevent inhaling toxic vapors. When using methanol all vapors must be removed by using appropriate air ventilation. If ventilation is insufficient the risk of explosion hazards can occur! The supplier of the bath liquid (methanol) will be able to hand over all chemical details and safety precautions related to the use of methanol. These precautions must be followed when operating the bath.

When operating the bath at a temperature below +5°C, in combination with water as bath fluid, ethylene-glycol should be added following the table below. The bath must be filled with a liquid suitable for the minimum operating temperature.

Do not use the water glycol mixture at temperatures where the mixture can start to freeze. Frozen bath fluid can severely damage the bath and stirrer mechanism.

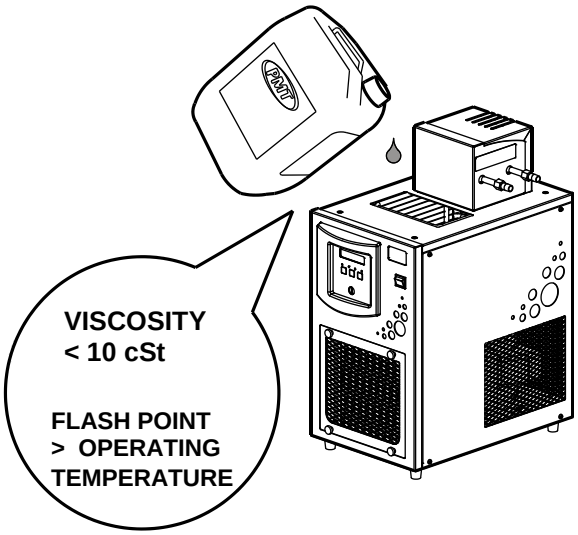
Commercial enterprises specialized in refrigeration may supply alternatives for mentioned circulation or bath fluids. These alternatives can be less toxic or combustible. However in some cases they are very corrosive for cupper, aluminum etc.

Working temperature [°C]	Mixture (volume percent)
5	90% water, 10% ethylene-glycol
0	80% water, 20% ethylene-glycol
-10	70% water, 30% ethylene-glycol
-15	65% water, 35% ethylene-glycol
-30	Methanol only

D

o not use destilled water. This water can lead to corrosion of the bath and moving parts. The corrosion can wear out the pump bearings. Reverse osmosis water can be used without problem.

It is very important to select a liquid with a viscosity of less than 10 cSt at the operating temperature and a flash point which is well above the operating temperature.



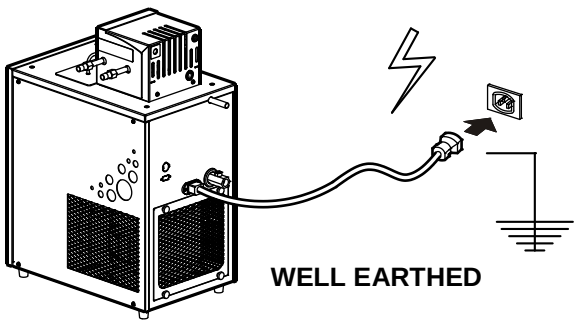
When using Methanol as bath liquid be aware of the hazards:
- Take all necessary precautions to reduce fire hazard.
- Methanol can cause toxic vapors, use appropriate air ventilation.

The supplier of the bath liquid (methanol) will be able to hand over all chemical details and safety precautions related to the use of methanol. These precautions must be followed when operating the bath.

6 CONNECTING

Before plugging TLC15 or TLC30 into the mains socket, make sure the voltage of the bath corresponds to the local voltage and frequency.

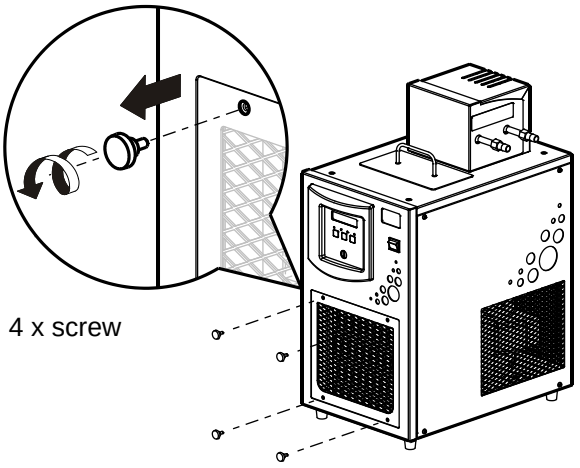
Use a mains supply that is well earthed, clean of interference and suitable for the acquired electrical load of the bath.

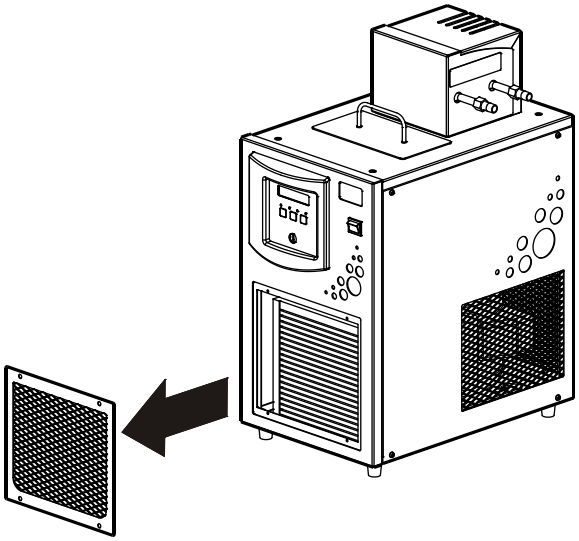


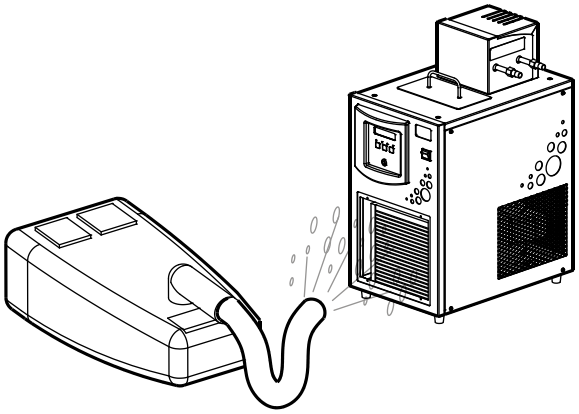
6.1 Cleaning

Regularly check the apparatus and condenser unit for dust. Remove dust with a vacuum cleaner.

Remove panel from TLC15 or TLC30. Use vacuum cleaner to remove dust.

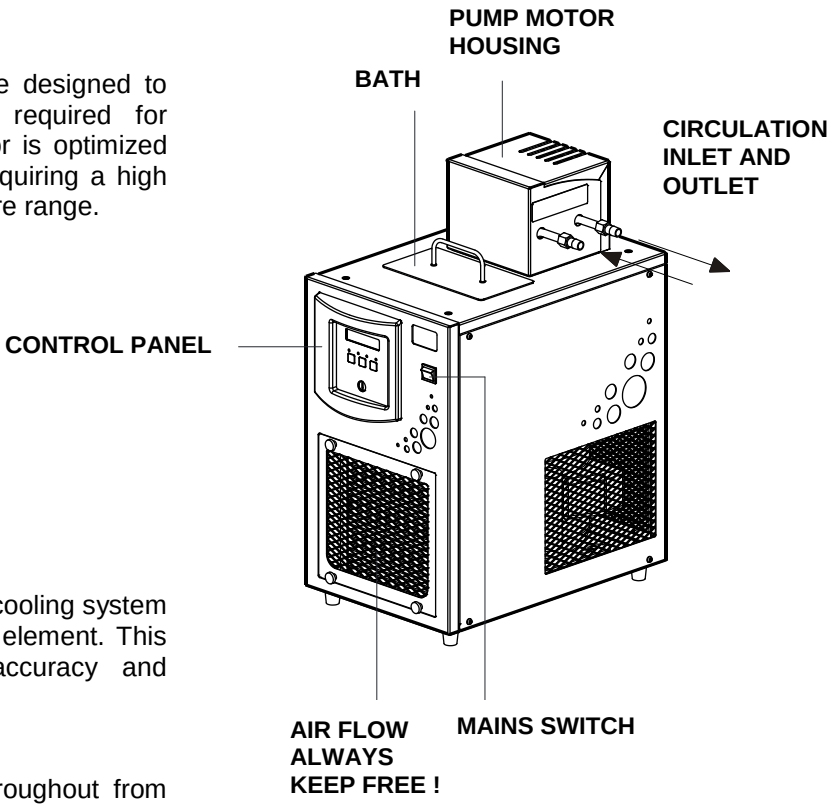






7 INTRODUCTION TO THE TLC SERIES

The TAMSON model TLC circulators are designed to perform accurate temperature control required for general laboratory. The Tamson circulator is optimized for temperature control of applications requiring a high degree of stability over a broad temperature range.



7.1 General

The TLC apparatus is a combination of a cooling system and a microprocessor controlled heating element. This design ensures a high degree of accuracy and reproducibility of temperature controls.

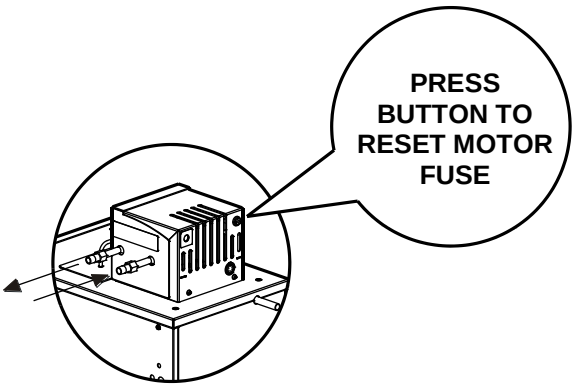
The TAMSON baths are constructed throughout from corrosion-resistant – stainless steel and Teflon – materials. Outher casing is zinc plated powder coated steel. The bath is effectively insulated against heat loss by a layer of Armaflex® rubber between the inner tank and outer casing.

7.2 Pump

A circulation pump is built-in to guarantee an uniform temperature distribution within the bath and providing the possibility to circulate through a closed external system.

The pump offers a capacity of 10 liters / min and a max pressure of 3 m head of water [3mtr H2O].

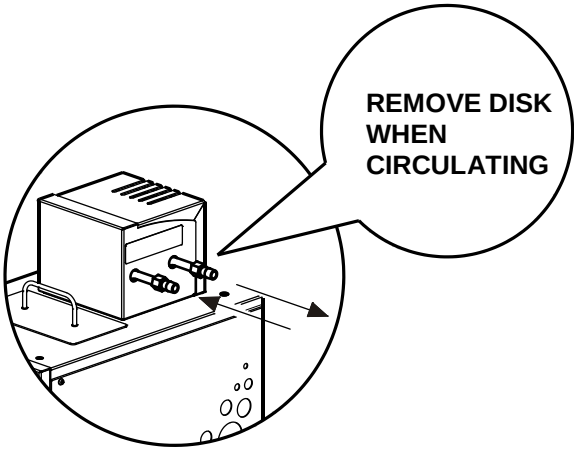
The standard pump offers a motor protection (small thermal fuse) which is placed on the back panel of the motor compartment. This protects the motor from excessive loads.



When pumping viscous liquids the thermal fuse can be activated. The motor fuse can be reset by pressing the button.

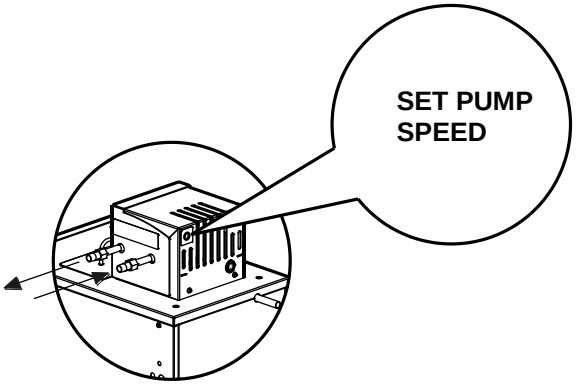
The inlet and outlet of the pump are fitted with 8..10 mm hose connections and 1/4" threaded fittings for metal tubing. The outlet (most near to the backside of the apparatus) is provided with a small disc, stopping the circulation action.

Before the fluid can begin circulating through external systems this disc must be removed by unscrewing the fitting and hose connection removing the disc.



7.3 Temperature control

Temperature control and setting the bath temperature is regulated using a PT-100 temperature probe Class A connected to a microprocessor module. The advanced electronic control system continually computes the energy input required for optimal temperature accuracy and stability. Temperature read-out is on a 2 x 16 character LCD. The actual set point is computed within the controller with an accuracy of 0.001°C.



8 OPERATION

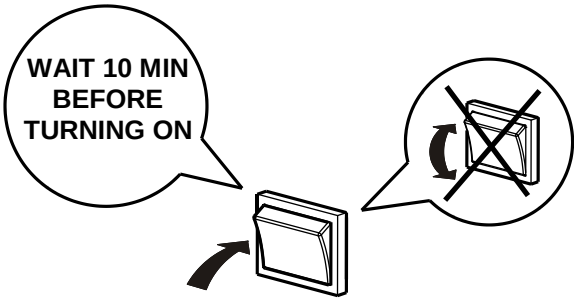
8.1 Switching on

If the bath has been properly filled with fluid it can be switched on with the mains switch located on the front panel. Chose a working temperature (set point).

8.2 Caution with powering on/off

Be careful and do not toggle with the on/off switch. To start the cooling compressor high currents are needed which will heat the compressor motor internally. Switching off and on the compressor several times will lead to mechanical damage.

When switching off the apparatus, wait for 10 minutes before switching the system back on again.



1x

8.3 Safety systems

In case of electronic failure the possibility exists that the heater element is continuously switched on. This will cause extreme temperature rise. To prevent high temperatures the bath is fitted with a mechanical over-temperature protection thermostat. This thermostat will switch-off the bath at a pre set temperature in the range from 50 to 270°C.

We advise to adjust the mechanical over temperature to approximately + 25°C above the bath set point.

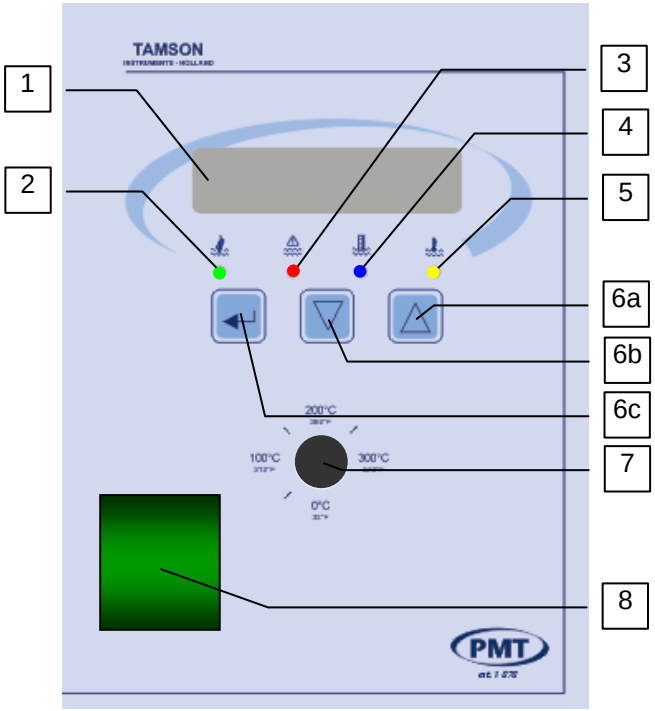
This safety construction prevents for example oil to be heated above flaming-point which will cause fire or prevent evaporation of bath fluid due to high temperatures.

The thermostat will automatically reset when the bath temperature drops approximately 10°C below the pre-set temperature. To continue normal operation the bath has to be switched off and on again.

8.4 Adjusting the mechanical over-temperature protection thermostat

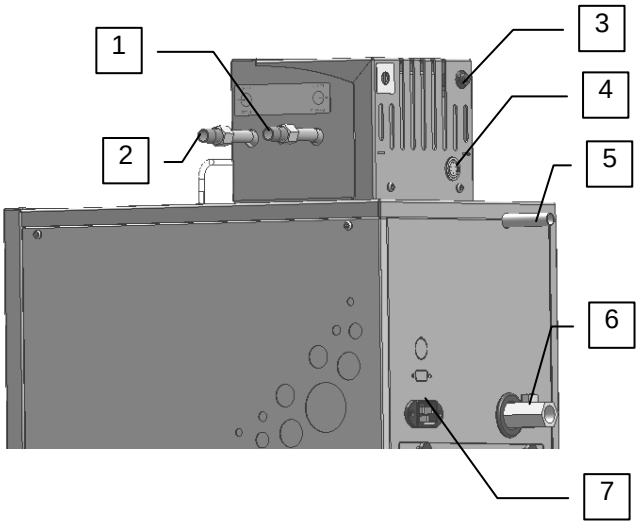
Turn the thermostat clockwise (7, drawing 1) to its maximum. Be aware that the safety thermostat is now only functioning at 270 °C. Heat the bath to the appropriate set point. Gently turn the thermostat anti-clockwise, until the over-temperature protection is activated, and system switches off, Turn the thermostat approximately 30°...40° higher (turn clockwise). Switch the bath off and on again. The bath is ready to operate safely.

8.5 Control Panel



1 LC Display
2 Heater indicator (Green)
3 Over temperature indicator (Red)
4 Level indicator (Blue), optional
5 Offset (Yellow)
6 Up(a), down(b), enter(c) buttons
7 Over-temperature protection
8 Mains switch

8.6 Backside apparatus



1 Outlet pump (pressure side). 1/4" outer straight BSP-gas fitting with connection for hose (8-10mm inner diameter),
2 Inlet pump (return). 1/4" outer straight BSP-gas fitting with connection for hose (8-10mm inner diameter),
3 Motor fuse,
4 Optional: Remote PT100,
5 Overflow, 10mm diameter,
6 Bath drain,
7 RS232 serial port, sub-D, female 9 pole.

8.7 Front panel keys

The front panel layout shows 3 operating keys:

PAGE

DOWN

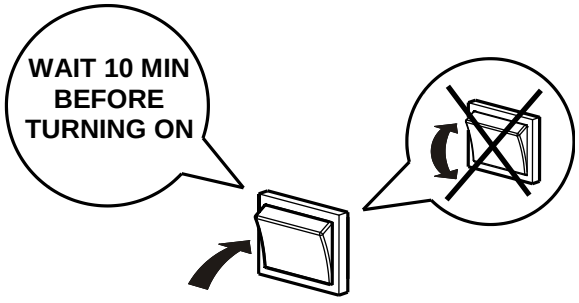
UP

The “Page” Key offers following:
- Temperature readout in °C,
- Temperature set point in °C,
- Changing the tuning (PID) parameters,

The “Up and Down” keys allow changing the listed value. All changed values like set point and PID parameters will be kept in memory even after switching of the power supply.

9 OPERATING THE SYSTEM

When the bath is ready for use it can be switched on by pressing the mains switch.



When switching off the apparatus, wait for 10 seconds before switching the system back on again.

The electronics are suited for both 50 and 60 Hz.

Page

Down

Up

The front panel layout shows the following 3 operating keys:

- Set point
- Offset**(press: <-5.00 .. +5.00°C step 0.01°C)
- Max Power (press: low, med, hi, max)
- Boost heater (press on / off)
- Time const (press: fast, medium slow, precise)
- Stirrer *
- Low alarm *
- High alarm *
- PID parameter:
  (PID set 1, PID set 2. PID set 3, PID set 4)
  - Proportional band (Pb=1/P where P is proportional value)
  - Integral value
  - Differential value
- Backlight
- Temp units
- Baudrate

* optional

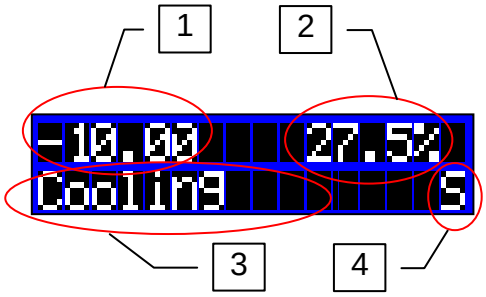
** This value is added to the measured temperature by the microcontroller. This way the temperature readout can be synchronized with an external calibrated measuring device like the TT3.

note: ☞ Display switches back automatically to temperature readout. Changed values are stored. Or Press to confirm when settings are altered.
☞ Each time is pressed another option is displayed.

Up and **Down** keys allow changing the listed value. All changed values, like set point and PID parameters, will be kept in memory when pressing the page key to leave the menu. After switching off the power supply, changed values are kept in memory.

The Tamson Thermometer **"TT3"**. This can be used as an external calibrated temperature readout.

9.1 Display readout



1 Temperature readout
2 Applied percentage of power
3 Operating mode
4 Indicator, alarm high, alarm low, control stable

Ad 1: When the controller starts or is restarted, the displayed value increases to a stable readout appears after a few seconds.

Ad 2: The controller calculates every second the amount of power which should be applied for stable control. The value is displayed with a resolution of 0.1% and ranges from 0% to 99.9%.

Ad 3:

Boost	Bath is heating to set point
Cooling	Bath is cooling down to set point
Tuning Ratio	Bath is tuning for power needed
Tuning SA	Bath is tuning, second step
PID SP=25.00	Bath is controlling, set point is 25.00°C (example)

Ad 4:

- Bath control is stable

Optional:

- Alarm high, press button to reset
- Alarm low, press button to reset

9.2 Quick start, adjust set point

To start operating the bath:

Fill the bath with fluid to flood the cooling coil, However do not fill the bath fully to the maximum.
Place the power plug, switch the bath on using the mains switch,
Choose a working temperature (set point):
Press ↵ once. Display will indicate "set point". Alter set point temperature by using up and down key to select the desired bath temperature. Press ↵ to confirm and display bath temperature again.

9.3 Tuning

Tuning can be done manually. The parameters mentioned in Table 1 will influence the control of the bath.

The PID parameters are set to

P	I	D
25	16	0

These parameters work fine for following bath contents:
- Water
- Water / Glycol
- Silicone oil, < 10cSt @ 25°C
- Mineral oil, < 10cSt @ 25°C

The temperature control of the bath is based on a digital PID system. When using different fluids in the bath each with their own heat capacity, the use of external cooling and external connected processes (circulation), or working at different set point temperatures requires new settings of the PID parameters. These parameters have to be optimized after changes to the system when optimal and accurate temperature control of the bath liquid is required.

Tuning of the bath results in:
Stable temperature control of the bath,
No over- or undershoot of the temperature set point,
Quick response to deviations from the set point caused by external disturbances.

Parameter	Description	Display
Proportional band	The bandwidth in display-units over which the output power is proportional between minimum and maximum	Pb
Integration time	Determines the time taken by the controller to remove steady state error signals	Ti
Derivative time	Determines the time taken by the controller to react on error signals.	Td

Table 1 Parameters influencing the temperature control

9.4 Manual tuning

The parameters for the PID control can also be changed manually. The control also allows to set the I and D values to zero. The bath will then function as a proportional system. The “P” parameter can than be varied to an optimal value by trial and error. A higher P will stabilize the system when I and D are off. The PID parameters can also be determined with the use of the Ziegler Nichols method described below.

Manual tuning by Ziegler-Nichols
With the process at its normal running temperature:

Set the integral time “Ti” and the derivative Time “Td” to off

Ignore the fact that the temperature may not settle precisely at the set point
If the temperature is stable, reduce the proportional band Pb so that the temperature just starts to oscillate. If the temperature is already oscillating, increase the proportional band until it begins oscillating. Allow enough time between each adjustment for the loop to stabilize. Make a note of the proportional band value “B” and the period of oscillation “T” Set the Pb, Ti and Td parameter values according to the calculations given in the table below

Type of control	Proportional band	Integral time "**ti**"	Derivative Time "**td**"
Proportional only	2xB	Off	Off
P + I control	2,2xB	0,8xT	Off
P + I + D control	1,7xB	0,5xT	0,12xT

10 MENU ITEMS

Use the front panel buttons △ and ▽ to select a menu. After pressing ↵ a ◇ sign appears next to the value indicating the value can now be changed. Pressing the up or down button again activates the value immediately. When the value is changed the value can be accepted bij pressi↵ The new value will be

accepted. When not pressing ↵ the value will be stored automatically after 5 seconds. The display than returns back to normal operating mode.

10.1.1 Menu item "Setpoint"

Select the set point temperature. Resolution is 0.01°C +/- the system accuracy.

10.1.2 Menu item "Offset"

The temperature displayed can be increased or decreased with an offset ranging from +5.00 down to -5.00 °C in steps of 0.01°C. This way the temperature reading on the display can be synchronised with an independent separate thermometer.

10.1.3 Menu item "Max Power"

(press: low 25, med, hi, max)
Limits the applied power by a maximum value:

Low	Maximum of 25% applied
Medium	Maximum of 50% applied
High	Maximum of 75% applied
Maximum	100% power is applied

10.1.4 Menu item "Boost heater"

No boost heater is mounted in the TLC series. This option will be inactive. A boost heater in some products is used to quickly heat up the bath. This menu item enables or disables the heater.

10.1.5 Menu item "Time const"

Used to select time to tune. The option precise has to be used to reach maximum temperature accuracy. Options are:

- Fast	60 seconds
- Medium	120 seconds
- Slow	180 seconds
- Precise	240 seconds
Standard value:	Precise

10.1.6 Menu item "Stirrer"

This menu item normally is deactivated and not visible.
(Stirrer 0 .. 100% (step 6%). Inactive)

10.1.7 Menu item "Low alarm"

This menu item normally is deactivated and not visible.
min SP to max SP. resolution 0.1°C. No hardware connected, display only

10.1.8 Menu item "High alarm"

This menu item normally is deactivated and not visible.
min SP to max SP. resolution 0.1°C. No hardware connected, display only.

10.1.9 Menu item "PID parameter"

PID set 1
PID set 2 - deactivated
PID set 3 - deactivated
PID set 4 - Activated when communication via RS232

Each set offers independent PID settings for:
Proportional band
Integrating
Differentiating

Default settings
Pb* := 25
I := 16
D := 0
*Pb= proportional band. Proportional value P is found to be 100/Pb.

10.1.10 Menu item "Backlight"

On
Off
Standard value: On

10.1.11 Menu item "Temp units"

°C
°F
Standard value: °C

10.1.12 Menu item "Baudrate"

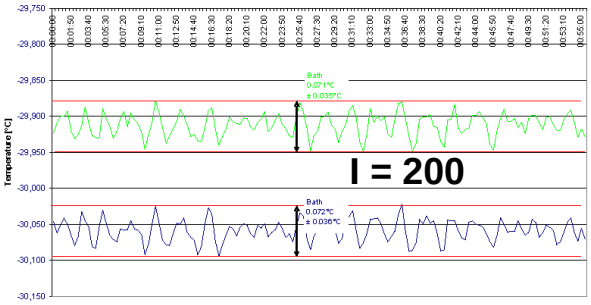
300
600
1200
2400
4800
9600
19200
38400
Standard value: 9600

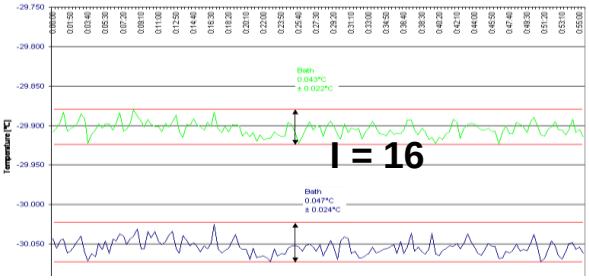
10.1.13 Menu item "Restart"

Restarts system.

10.2 PID configuration

The two graphs below show the influence of the integral setting. The graph on top has a setting of 200 for the integral parameter. The bottom graph has a setting of 16. The value of 200 causes less stable control.





10.3 Manual tuning

The temperature control of the bath is based on a digital PID system. Following may require specific PID setting to optimise the temperature control:
- the use of different fluids with different specific heat,
- Circulating different loads
- Working at different set point temperatures

Parameter	Description	Display
Proportional band	The bandwidth in display-units over which the output power is proportional between minimum and maximum	P
Integration time	Determines the time taken by the controller to remove steady state error signals	I
Derivative time	Determines the time taken by the controller to react on error signals.	D

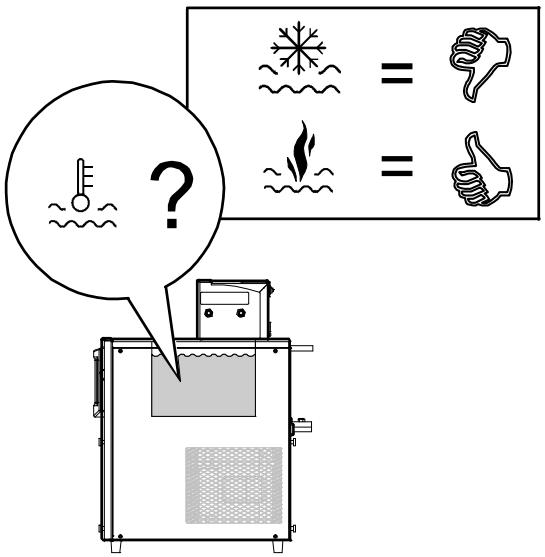
Table 2 Parameters influencing the temperature control

10.4 Standard PID settings

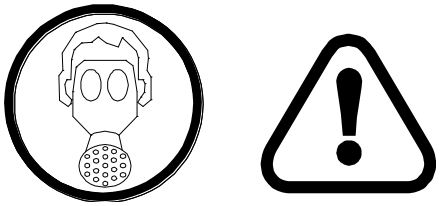
P = 25
I = 16
D = 0

10.5 Draining bath fluid

Before removing flammable bath liquids take the appropriate fire hazard precautions against these liquids.

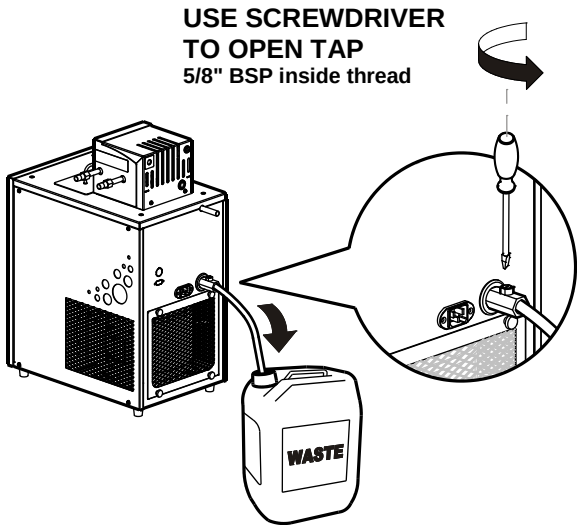


When removing bath fluid do not inhale toxic vapor. Always use appropriate ventilation.



10.5.1 Using the drain tap

The TLC baths can be drained via the drain tap located at the backside of the apparatus.



For safety reasons the tap can only be opened by using a screwdriver. The thread inside the tap is 5/8".

10.6 Maintenance

Keep the apparatus free from dust. Regularly check the cooling openings and remove dust with vacuum cleaner. If necessary remove cover and clean internally. Use appropriate protection when cleaning, dust can be very unhealthy.

10.7 Maintenance

Keep the apparatus free from dust. Regularly check the cooling openings and remove dust with a vacuum cleaner. If necessary remove cover and clean internally. Use appropriate protection when cleaning, dust can be very unhealthy.

11 TROUBLE SHOOTING

11.1 General

The motor is not running and the lamps are not on.	Check the main voltage and all electrical connections, including switches. Check fuse in wall socket of mains supply.
Motor is not running, lamps and electronics operate (the motor turns freely by hand).	Motor overloaded. The motor protection may trip because of mechanical overloading of the pump. Reset fuse by pushing button on rear side of blue motor housing. The motor capacitor has a defect. Replace motor capacitor inside the system. Malfunctioning wiring. Check wiring.
Compressor is making “clicking” noise	Bath has been switched on and off too quickly. Wait approximately 10 minutes before switching on again. The clicking noise is a temperature fuse inside the compressor preventing it from overheating.
Compressor will not start	When the machine has been switched off the pressure in the cooling circuit can rise to a high level. For this reason the apparatus has to settle the pressure of the cooling liquid for several minutes (5 ... 10) before it can be restarted. When this problem occurs more often it will indicate that dust is blocking the condenser circuit. Clean the inside of the system and remove all dust from the condenser unit and fans with a vacuum cleaner. Do not use pressurised air remove dust. The flying dust particles can damage the fan bearings, are very unhealthy when breathed in and can lead to severe eye problems.
Temperature not stable	Place top lid on the bath. Load fluctuates.

Temperature does not drop	Bath is not properly insulated. Place top lid on the bath. External load consumes to much heat removal (generates too much heat). The load exceeds the heat removal capacity.

11.2 Faulty temperature readings

The temperature read out on the display does not correspond to the temperature measured.

- PT100 is defective,
- Offset value is set to a wrong value.

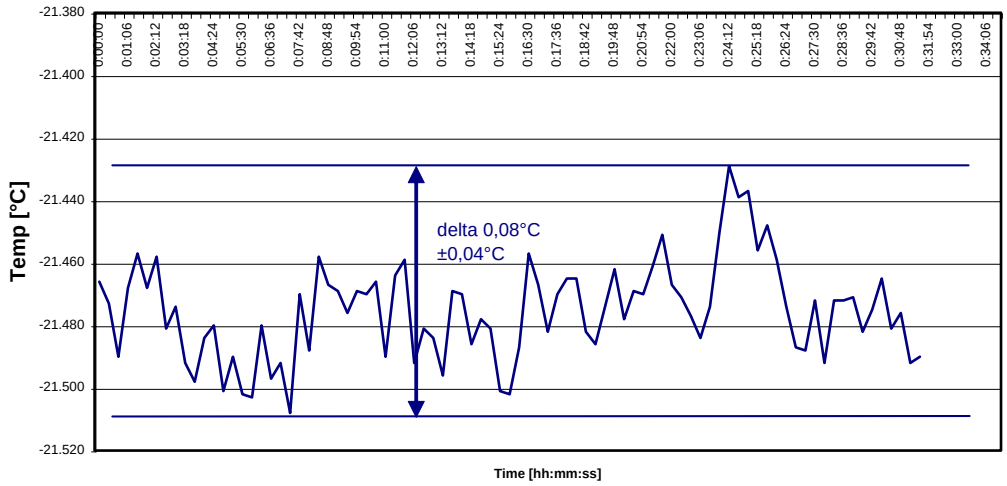
12 SPECIFICATIONS

12.1 Technical specifications overview

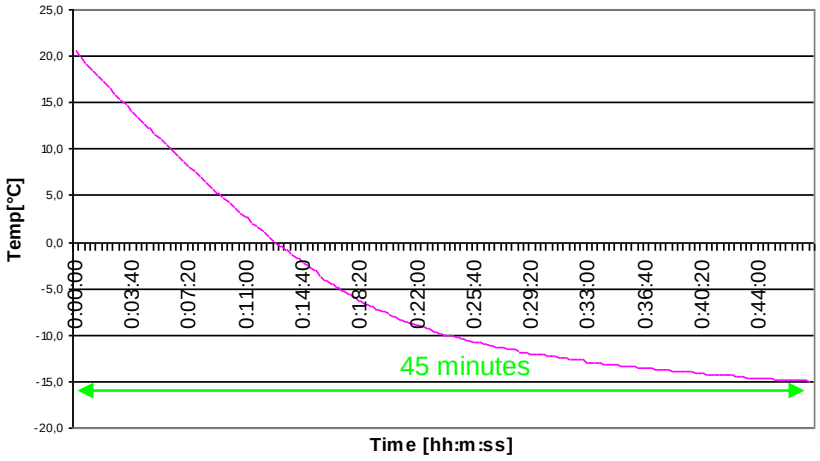
Item	Unit	TLC15-5	TLC30-5
Power	[Watt]	1400	
Used materials Inside bath		Stainless steel PTFE(Teflon)	
Range	[°]	-15..+60 °C 5..140°F	-30..+60°C -22..+140°F
Reading	Standard °C, °F on request		
Setting ±	[°]	0.01	
Stability ±	[°K]	Better than 0.05	
Heating	[W]	1100 (1 heater)	
Bath volume	[L]	5	
Pump pressure	[mm H2O]	300 max	
Pump cap.	[L/min]	7 max	
Compressor	[W]	220	
Opening bath	[mm]	85 x 150 (Effective use)	
Depth bath	[mm]	150	
Length	[mm]	420 (460 iwith drain)	
Width	[mm]	265	
Height	[mm]	565	
Weight	[Kg]	30	
CE	Conforms to CE regulation		

12.2 TLC15 performance

12.2.1 Stability TLC15 - TLC30

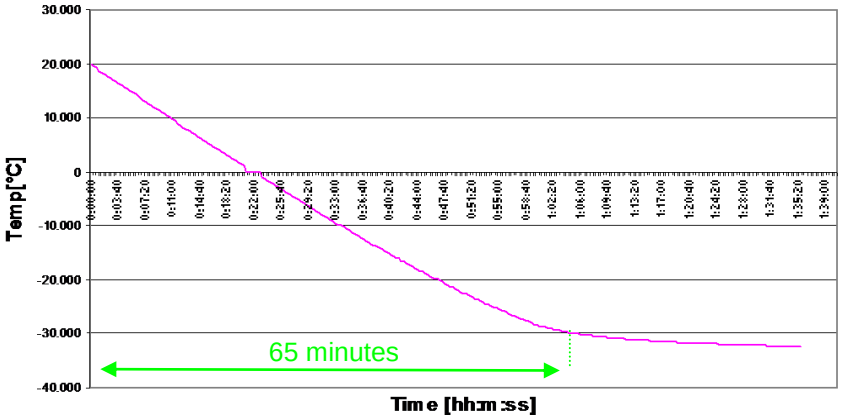


12.2.3 Cooldown TLC15



Remark: The cool down and heat up is based on a bath filling with methanol. Other fluids will have different and in most cases longer cool down/heating up time due to their difference in specific heat.

12.2.4 Cooldown TLC30



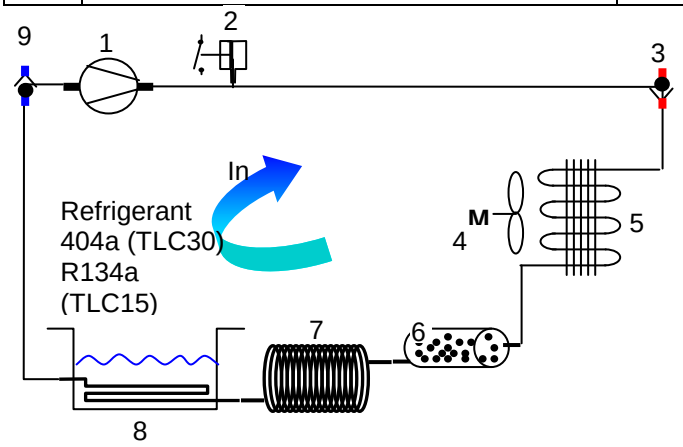
Remark: The cool down and heat up is based on a bath filling with methanol. Other fluids will have different and in most cases longer cool down/heating up time due to their difference in specific heat.

12.3 Spare parts list TLC15/TLC30

230 Volt 50HZ	230V 60HZ	115 Volt 60Hz	Description
04T0210		04T0221	Pump complete
04T0225			DC Performance pump complete
25T1305			24V - DC Motor
06T0515			PCB pump control
24T0018			Power supply
25T1295		25T1301	Motor for pump
25T1343		n.a.	Capacitor 2uF
n.a.		25T1344	Capacitor 7uF
25T0251		25T0252	Heater 1100 Watts
24T8081		n.a.	Motor fuse 0.3 Amp.
n.a.		24T8080	Motor fuse 0,6 Amp.
25T1244		25T1245	Cooling fan
06T0514		06T0524	Mains board with filter and relay (PCB-TTU)
24T8581			Mechanical safety thermostat
04T2070			Bearing cover with bearing
04T2135			Bearing PTFE
22T3520			Filling valve
24T8540			Mains switch
28T4015			Front foil
25T2310			PT-100 sensor
06T0518			Controller

13 PRINCIPAL OF OPERATION

TLC30/15			
1	Compressor	6	Dryer
2	Safety overpressure switch	7	Throttle (Capillary)
3	High pressure side	8	Evaporation (Bath)
4	Fan condenser	9	Low pressure side (suction)
5	Condenser		



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